AN EVALUATION OF THE SHEBANDOWAN LAKES SYSTEM, DISTRICT OF THUNDER BAY

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Ministry of the Environment
Ontario

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Director
Northwestern Region

AN EVALUATION

OF

THE SHEBANDOWAN LAKES

SYSTEM

DISTRICT OF THUNDER BAY

BY

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WATER ASSESSMENT

TECHNICAL SUPPORT SECTION

NORTHWESTERN REGION

MINISTRY OF THE ENVIRONMENT

TABLE OF CONTENTS

INTRODUCTION

During 1972 a general water quality assessment of the Shebandowan Lakes was undertaken in response to increasing pressure on the provincial government to free more shoreline for cottage development and a number of observations by concerned individuals which suggested that the quality of these waters was visibly deteriorating. Relative to the latter, it has been reported by persons having a lengthy association with the Shebandowan Lakes that the weed growths are more abundant now than previously remembered. The Shebandowan Lakes system is an important recreational resource supporting a valuable sport fishery and considerable recreational usage associated with its shoreline development of homes, cottages and resorts.

Results of the study undertaken in 1972 have been partially documented in an earlier report entitled "Aquatic Macrophyte Report of the Shebandowan Lakes System" which related specifically to one aspect of the investigation. This report provides the findings of the entire investigation carried out on the Shebandowan Lakes during the summer of 1972.

DESCRIPTION OF STUDY AREA

The Shebandowan Lakes system (Figure 1) is situated approximately 80 kilometers (50 miles) northwest of the City of Thunder Bay in the District of Thunder Bay.

The system has an east-west axis with a total length of 36.4 kilometers (24 miles) and a width of 2.3 kilometers (2 miles) at its widest point. The chain is divided into three bodies of water known as Upper, Middle and Lower Shebandowan Lakes. The lakes have a total surface area of approximately 58.3 square kilometers (22.8 square miles) and drains a watershed of approximately 1188 square kilometers (457 square miles).

Drainage to the Shebandowan Lakes is contributed by six major streams; Greenwater and Firefly Creeks and the Kashabowie River in Upper Lake Shebandowan; Kabaigon Creek in Middle Shebandowan and Harnden Creek and the Swamp River in Lower Shebandowan Lake. There are a number of other small creeks and tributaries which complete the inflowing waters. The only outflow is the Shebandowan River which drains the system at the townsite of Shebandowan at the eastern extreme of Lower Shebandowan Lake. The Shebandowan River eventually joins the Kaministikwia River which discharges into Lake Superior. The system lies in a region of acidic precambrian formation with an overburden of shallow, sandy soils and local pockets of deep sandy deposits.

The area receives an annual rainfall and snowfall of 68.6 and 203.2 centimeters (27.0 and 80.0 inches) respectively and is further characterized by an average July temperature of 18° C (64° F) and a January temperature of -16° C (7° F).

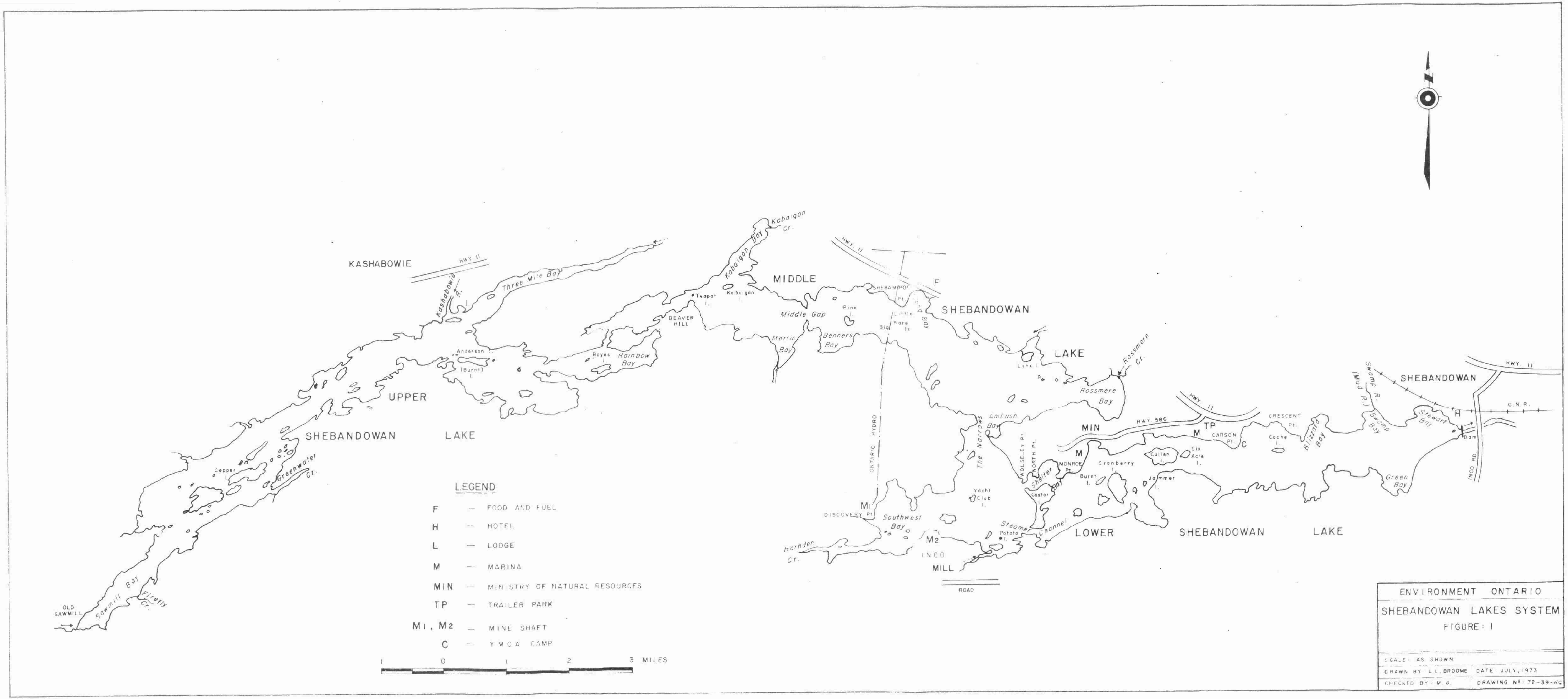
The surrounding watershed is covered with spruce, fir, poplar, white birch and jackpine. Substantial reserves of base metal ores occur in the vicinity of the Shebandowan Lakes. One ore deposit is presently

being mined and milled on Lower Shebandowan Lake. All wastes from the mining and milling operation are discharged following treatment into Gold Creek which enters the Matawin River. This river joins the Shebandowan River downstream of Lower Shebandowan Lake.

Cottages in the area number approximately 750, the majority of these being concentrated along the shoreline of Lower Shebandowan Lake with a small proportion on Middle Shebandowan Lake. Upper Lake Shebandowan is virtually unpopulated except for a number of lodges and camps at the mouth of the Kashabowie River. In most instances, treatment facilities for domestic waste consist of sub-surface disposal by means of septic tanks and field tiles. In some localities where conditions are suitable, lagoons have been utilized on a community basis.

Part of the lake system was formerly used for floating logs to local sawmills scattered along the shoreline, however, wood reserves in the area have been exhausted and these activities have ceased. Present day use of the Shebandowan Lakes includes water-skiing, sailing, swimming, fishing and other water oriented recreational activities as well as a water supply source for summer camps and the mining operation on Lower Shebandowan Lake. The lake also serves as a storage reservoir for hydro power generation in the Kaministikwia River.

Fish in the system include bass, walleye, pike, whitefish, cisco, whitesucker, burbot, perch, and lake trout, the latter being an indigenous and once plentiful species which is now reported to occur in the lakes in low numbers.



KASHABOWIE
HWY. 11
Kashabowie R.
Three Mile Bay
UPPER
SHEBANDOWAN LAKE
Anderson I.
(Burnt) I.
Boyes I.
Rainbow Bay
Copper I.
Greenwater Cr.
Sawmill Bay
Firefly Cr.
OLD SAWMILL
BEAVER HILL
Teapot I.
Kabaigon I.
Kabaigon Bay
Kabaigon Cr.
MIDDLE
SHEBANDOWAN
LAKE
Middle Gap
Martin Bay
Benners Bay
Pine I.
Big
Little Rare Is.
SHEBAMPOR Pt.
F
Lynx I.
Rossmere Bay
Rossmere Cr.
ONTARIO HYDRO
The Narrows
Lmtush Bay
MIN
HWY. 586
HWY. 11
TP
M
CARSON Pt.
C
CRESCENT Pt.
Cache I.
Blizzard Bay
Swamp R.
(Mud R.)
Swamp Bay
Stewart Bay
H
Dam
SHEBANDOWAN
HWY. 11
C.N.R.
INCO RD.
WOLSELEY Pt.
NORTH Pt.
MONROE Pt.
Shelter Bay
Castor
Cranberry I.
Cullen I.
Six Acre I.
Burnt I.
Jammer I.
Green Bay
Yacht Club I.
M1
DISCOVERY Pt.
Southwest Bay
M2
INCO MILL
Harnden Cr.
Steamer Channel
Potato I.
LOWER
SHEBANDOWAN
LAKE
ROAD
LEGEND
F — FOOD AND FUEL
H — HOTEL
L — LODGE
M — MARINA
MIN — MINISTRY OF NATURAL RESOURCES
TP — TRAILER PARK
M1, M2 — MINE SHAFT
C — Y.M.C.A. CAMP
1 0 1 2 3 MILES
ENVIRONMENT ONTARIO
SHEBANDOWAN LAKES SYSTEM
FIGURE: 1
SCALE: AS SHOWN
DRAWN BY: L.L. BROOME
DATE: JULY, 1973
CHECKED BY: M.G.
DRAWING No: 72-39-WQ

EXPLANATION OF EUTROPHICATION

Lakes of the north temperate region have been classified according to their productivity as being either oligotrophic, mesotrophic or eutrophic. Of these, the unproductive but highly esteemed oligotrophic waters can be characterized in general terms as being deep in nature; containing cool, clear and nutrient deprived waters and supporting cold water fish species such as trout, whitefish and burbot. In contrast, the highly productive but less esteemed eutrophic lakes are characteristically shallow, warm, turbid and nutrient enriched bodies of water which support associations of warm water species such as walleye, pike and bass. Lakes with intermediate characteristics are termed mesotrophic.

In the lake environment, eutrophication or a natural aging process occurs, with the transition being one from oligotrophic to eutrophic conditions. At any one point in time the 'age' of a lake can be established by examining its productivity which in turn is determined by the physical, chemical and biological characteristics of the lake. Owing to external factors such as the input of material to the lake either from the atmosphere or its drainage basin, an increase in the potential energy occurs which in turn may be converted into plant or animal tissue (i.e. increase in productivity). In simplistic terms this is the natural process of lake aging or eutrophication which in the absence of man's influence occurs at a very slow pace, too slow to be measurable in a single generation of man. The lake system, however, is capable of responding very rapidly to the influence of man and can, as a result of artificial enrichment progress very rapidly from an oligotrophic state to one having most of the characteristics of a eutrophic lake. In many cases the input of nutrients stimulates a chain

reaction commencing with increased plant production which in turn influences most of the physical, chemical and biological components of the lake ecosystem. To the casual observer these changes become readily evident in the form of alterations in numbers and species of fish as well as in the production of plant material.

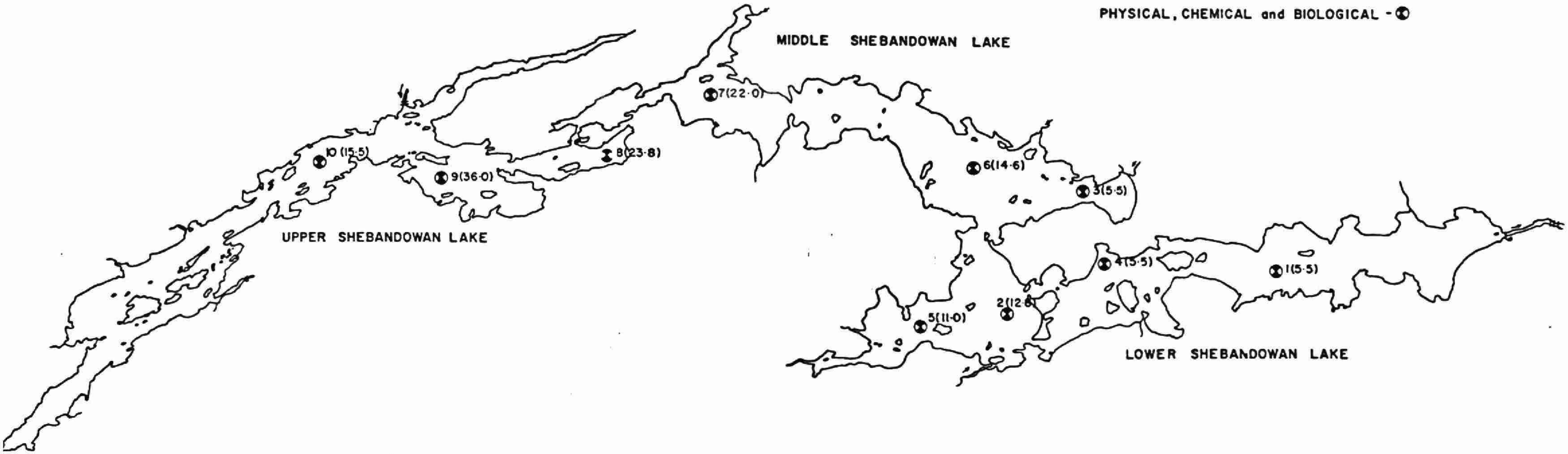
Comments and observations which have been provided by local residents and persons having a lengthy history of association with the Shebandowan Lakes have pointed towards the symptoms of artificial eutrophication. It is suggested that plant production in these waters is more abundant now than previously remembered and it can be documented, for example, that lake trout are less abundant now than in the past. Unfortunately, there are also additional factors such as lake water levels, climate, fishing pressure and the introduction of fish species which can also produce the symptoms which have been described. The following section of this report will be devoted to an analysis of technical data in an attempt to clarify the extent to which the Shebandowan Lakes system has been influenced by cultural eutrophication.

FIGURE 2

STATION LOCATIONS

DEPTH - (m)

PHYSICAL, CHEMICAL and BIOLOGICAL -



METHODS

In order to assess the possible influence of shoreline development on water quality of the Shebandowan Lakes system in the absence of historical water quality information, the study was approached on the basis of a comparison of existing water quality in Upper, Middle and Lower Shebandowan Lakes. The assumption in this case being that Lower Shebandowan Lake, with its greater shoreline development, would be more productive than Middle Shebandowan and that Upper Shebandowan Lake would be the least productive body of water.

On this basis, four stations on Lower Shebandowan, three stations on Middle Shebandowan and three stations on Upper Shebandowan (see figure 2) were sampled for physical, chemical and biological parameters on eight occasions between June 10th and September 10th, 1972. A detailed account of the methodologies employed is provided in appendix A.

RESULTS

Physical Aspects

Temperature

On June 12th,1972,the first sampling run, the waters of Upper, Middle and Lower Shebandowan Lakes were thermally stratified and remained so throughout the duration of the study period. Initially, the thermocline or zone of rapid temperature change occurred at the six to seven metre level. By the end of the survey the thermocline had lowered to occupy the nine to thirteen metre level.

Stations 1, 3, 4 and 5 exhibited weak thermal stratification, however, a thermocline did not permanently establish itself at these stations during the study period.

Surface water temperatures of Upper, Middle and Lower Shebandowan Lakes ranged from 17 to 22° C throughout the study period. In contrast the bottom waters of Upper Shebandowan Lake, the deepest of the study lakes,ranged between a maximum of 5.5°C at Station 8 to 8°C at Station 10 whereas maximum temperatures at the bottom of Middle Shebandowan Lake reached 10°C at Stations 6 and 7 and 11°C at Station 2 on Lower Shebandowan Lake.

Light Transmission

A summary of the secchi-disc values for the Shebandowan Lakes is provided in Table 1. Mean secchi-disc readings for Upper, Middle and Lower Shebandowan Lakes were 4.0, 4.2, and 4.1 metres respectively.

Table 1: Secchi Disc values (m.) for 10 Stations on Lake Shebandowan during 1972.

STATION	JUNE 12	JUNE 27	JULY 4	JULY 17	AUG. 1	AUG. 9	AUG. 28	SEPT. 6
1	2.3	2.6	2.4	2.3	2.4	2.7	2.3	-
2	4.3	3.7	4.3	3.7	4.0	4.0	4.9	-
3	2.0	2.1	2.3	2.1	3.0	2.3	2.0	2.3
4	1.8	2.1	1.8	2.1	2.3	2.7	2.1	-
5	4.6	4.1	4.6	3.7	4.1	4.0	5.0	3.0
6	4.3	4.0	4.0	3.8	4.3	4.3	4.6	4.3
7	5.0	3.7	4.0	4.0	4.0	4.6	4.6	4.3
8	4.0	3.8	4.0	4.1	-	4.6	-	4.6
9	4.3	4.0	3.7	3.4	-	4.3	-	4.3
10	4.6	4.0	4.0	3.7	-	4.3	-	4.0

Chemical Aspects

Alkalinity

Alkalinity values as expressed in Table 2 rarely exceeded 24 mg/l in any of the three lakes studied. Little difference was evident between the surface and bottom values comparing data from all stations.

Carbon Dioxide

Free CO_2 values are presented in Table 3 for the eight stations studied. Samples were first taken during the second visit (June 27) to the lakes, all three of which exhibited similar concentrations ranging from 0.9 mg/l to 1.4 mg/l at the surface. Similarly low surface water concentrations of CO_2 persisted throughout the study period with mean values being 1.7, 1.7 and 1.6 mg/l for Upper, Middle and Lower Shebandowan lakes respectively.

Marked differences were encountered in the water immediately above the bottom sediments in all three lakes. Upper Shebandowan Lake revealed a mean level of 9.6 mg/l with a maximum level of 12.3 mg/l being encountered on September 6th. Middle Shebandowan Lake had a mean level of 7.6 mg/l in the bottom waters, a maximum of 12.3 mg/l occurring during the last two visits. Data from Lower Shebandowan indicate a mean value of 6.2 mg/l in the bottom waters.

TABLE 2 CHEMICAL DATA (MAXIMUM, MINIMUM AND MEAN VALUES FOR EIGHT SAMPLING RUNS) FOR LAKE SHEBANDOWAN 1972. ALL VALUES ARE mg/l EXCEPT pH.

		SURFACE*			BOTTOM**		
STATION	PARAMETER	MAXIMUM	MINIMUM	MEAN	MAXIMUM	MINIMUM	MEAN
	Fe	.25	.10	.143	.20	.10	.136
	pH	7.6	7.2	7.44	7.6	7.2	7.41
1	Alkalinity	24	20	21.7	25	20	21.6
	Acidity	4	2	2.7	4	2	2.7
	Conductivity	56	50	53.2	56	49	52.8
	Silica	6.7	5.0	5.78	6.4	5.2	5.84
	Fe	.15	.05	.071	.10	.05	.071
	pH	7.8	7.3	7.51	7.2	6.9	6.97
2	Alkalinity	23	21	21.6	25	21	21.6
	Acidity	3	2	2.5	7	4	5.2
	Conductivity	58	53	56.0	66	58	60.2
	Silica	6.7	3.4	5.26	7.1	3.6	5.78
	Fe	.10	.05	.063	.10	.05	.063
	pH	7.7	7.3	7.48	7.8	7.1	7.43
3	Alkalinity	23	21	21.6	24	20	21.5
	Acidity	3	2	2.1	3	2	2.4
	Conductivity	58	53	55.6	58	53	55.4
	Silica	7.0	3.0	5.23	6.0	3.8	5.20
	Fe	.10	.05	.064	.10	.05	.079
	pH	7.6	7.2	7.46	7.5	7.3	7.44
4	Alkalinity	23	21	21.7	24	21	21.9
	Acidity	3	2	2.3	3	2	2.5
	Conductivity	58	52	55.4	58	52	56.0
	Silica	7.5	4.9	5.68	6.0	4.4	4.98
	Fe	.20	.05	.088	.10	.05	.075
	pH	7.9	7.1	7.49	7.5	6.8	7.16
5	Alkalinity	23	21	22.0	23	21	21.9
	Acidity	4	2	2.7	6	3	3.4
	Conductivity	60	57	58.4	60	56	57.8
	Silica	6.0	4.9	5.37	7.0	4.6	5.47

* 1 metre below surface ** 1 metre above bottom

TABLE 2 (Continued)

STATION	PARAMETER	SURFACE* MAXIMUM	SURFACE* MINIMUM	SURFACE* MEAN	BOTTOM** MAXIMUM	BOTTOM** MINIMUM	BOTTOM** MEAN
	Fe	.10	.05	.056	.20	.05	.106
	pH	7.7	7.3	7.46	7.2	6.7	6.84
6	Alkalinity	22	21	21.5	23	21	21.6
	Acidity	3	2	2.4	10	3	7.3
	Conductivity	55	52	53.8	59	56	57.4
	Silica	6.6	4.5	5.57	7.0	4.6	6.47
	Fe	.10	.05	.069	.45	.10	.194
	pH	7.7	7.2	7.40	6.8	6.6	6.70
7	Alkalinity	23	19	21.0	23	21	21.4
	Acidity	3	2	2.4	12	5	8.9
	Conductivity	53	50	51.8	57	52	55.4
	Silica	6.4	4.0	5.48	8.0	6.2	7.23
	Fe	.10	<.05	.075	.25	.10	.158
	pH	7.5	7.3	7.38	6.8	6.6	6.68
8	Alkalinity	22	20	21.0	22	20	21.0
	Acidity	4	2	2.8	12	5	8.4
	Conductivity	49	47	47.8	52	49	50.5
	Silica	6.7	4.0	5.53	8.6	7.5	7.88
	Fe	.10	<.05	.083	.85	.05	.442
	pH	7.5	7.3	7.40	6.8	6.6	6.71
9	Alkalinity	23	20	21.0	23	21	21.0
	Acidity	3	2	2.6	10	5	8.4
	Conductivity	49	47	47.8	56	51	53.8
	Silica	6.5	4.5	5.40	8.1	6.5	7.20
	Fe	.15	.05	.083	.40	.15	.258
	pH	7.5	6.9	7.33	7.4	6.6	6.88
10	Alkalinity	24	21	22.2	25	22	23.0
	Acidity	4	2	2.8	12	2	7.4
	Conductivity	60	49	52.5	54	51	53.3
	Silica	6.7	4.0	5.33	7.2	5.4	6.55

* 1 metre below surface ** 1 metre above bottom

Table 3: Free CO_2 values (mg/l) at 10 stations on Lake Shebandowan during 1972.

STATION		JUNE 12	JUNE 27	JULY 4	JULY 17	AUG. 1	AUG. 9	AUG. 28	SEPT. 6
1.	*S		1.40	1.30	1.80	2.6	1.40	1.80	
	B		2.30	1.30	1.80	2.3	1.80	1.80	
2.	*S		0.92	0.92	1.40	1.4	1.40	1.80	
	B		6.40	7.40	4.80	4.4	8.80	5.50	
3.	*S		1.40	1.30	1.80	1.4	1.40	1.80	1.80
	B		1.40	1.30	1.40	1.8	1.40	0.92	1.80
4.	*S		1.40	1.30	1.40	1.4	1.80	2.30	
	B		1.40	1.30	1.80	1.8	1.40	1.40	
5.	*S		0.92	1.30	1.80	1.4	2.30	1.80	1.80
	B		5.50	4.00	7.40	2.3	0.92	1.80	2.60
6.	*S		0.92	0.92	1.80	1.8	0.23	3.50	3.50
	B		6.90	8.00	6.40	8.8	7.40	8.80	2.30
7.	*S		1.40	1.80	1.40	1.8	1.80	1.80	3.10
	B		10.10	7.40	11.00	11.4	10.10	12.30	12.30
8.	*S		0.92	1.30	1.40		1.40		1.80
	B		9.70	7.40	10.1		10.10		8.40
9.	*S		1.40	1.30	1.40		1.40		2.30
	B		9.20	8.40	11.80		10.10		11.40
10.	*S		1.40	1.8	1.8		1.80		3.5
	B		7.4	6.6	11.4		9.20		12.3

*S Surface samples taken at 1 meter below the surface.

*B Bottom samples taken 1 meter off the bottom.

Dissolved Oxygen

During the study period the surface waters of the three lakes experienced little fluctuation in dissolved oxygen concentrations. A mean range of 8.1 to 8.9 ppm was encountered throughout the summer with an absolute minimum of 7.5 ppm occurring on the third visit (July 4th) to the study area.

In contrast the bottom waters of Upper and Middle Shebandowan had mean values of 4.5 and 4.6 ppm respectively whereas Lower Shebandowan Lake experienced a mean concentration of 3.6 ppm in the bottom strata. During the August 28th visit to the lakes, Lower Shebandowan Lake had a value as low as 1 ppm in the bottom waters.

Stations 1, 3 and 4 encountered no oxygen depletion in the bottom waters and levels remained similar to those encountered at the surface.

pH

Minimum, maximum and mean pH data is provided in Table 2. During the study period, surface pH values were similar for the three study lakes, however, a difference is noted between the bottom waters of Upper and Middle Shebandowan and those of Lower Shebandowan. The two lakes, Upper and Middle Shebandowan tend to be slightly more acidic than Lower Shebandowan in this strata of water. Generally, however, the three lakes exhibited near neutral pH values with 6.75, 6.77, and 6.97 for Upper, Middle and Lower Shebandowan Lakes respectively.

Acidity

Data are tabulated in Table 2. Acidity values correspondingly went up in the hypolimnion of all three lakes as the pH values came below the neutral point of 7. Both Upper and Middle Shebandowan, however, had a mean hypolimnetic acidity of 8.1 whereas Lower Shebandowan revealed a mean of 5.2.

Nutrient Parameters

Data are presented in tables 2 and 4. The total Kjeldahl values of the bottom waters of the three lakes are most significant. Mean values of .226, .245, and .273 PPM were obtained for Upper, Middle, and Lower Shebandowan Lakes respectively.

TABLE 4 CHEMICAL DATA (MAXIMUM, MINIMUM AND MEAN VALUES (mg/l) FOR EIGHT SAMPLING RUNS) FOR LAKE SHEBANDOWAN 1972.

		SURFACE*			BOTTOM**		
STATION	PARAMETER	MAXIMUM	MINIMUM	MEAN	MAXIMUM	MINIMUM	MEAN
1	Free Ammonia	.01	.00	<.01	.01	.00	<.01
	Total Kjeldahl	.58	.23	.335	.62	.20	.345
	Nitrite	.004	.001	.0027	.004	.001	.0023
	Nitrate	<.01	<.01	<.01	<.01	<.01	<.01
	Total Phosphorus	.023	.007	.0133	.009	.023	.0149
	Soluble Phosphorus	.007	.001	.0027	.006	.001	.0023
2	Free Ammonia	<.01	.00	<.01	.01	.00	<.01
	Total Kjeldahl	.30	.20	.264	.33	.22	.273
	Nitrite	.003	.001	.0020	.003	.001	.0017
	Nitrate	<.01	<.01	<.01	.06	<.01	.0034
	Total Phosphorus	.011	.006	.0090	.025	.007	.0146
	Soluble Phosphorus	.004	.001	.0023	.004	.001	.0030
3	Free Ammonia	.01	.00	<.01	.01	.00	<.01
	Total Kjeldahl	.35	.20	.286	.34	.19	.254
	Nitrite	.003	.001	.0018	.003	.001	.0019
	Nitrate	.01	<.01	<.01	.01	<.01	<.01
	Total Phosphorus	.028	.005	.0143	.019	.007	.0109
	Soluble Phosphorus	.002	.001	.0019	.005	.001	.0021
4	Free Ammonia	<.01	<.01	<.01	<.01	<.01	<.01
	Total Kjeldahl	.38	.18	.287	.44	.18	.303
	Nitrite	.003	.001	.0020	.003	.001	.0021
	Nitrate	<.01	<.01	<.01	<.01	<.01	<.01
	Total Phosphorus	.017	.007	.0109	.017	.005	.0117
	Soluble Phosphorus	.004	.001	.0021	.004	.001	.0020
5	Free Ammonia	.01	.00	<.01	.01	.00	<.01
	Total Kjeldahl	.34	.17	.271	.32	.17	.260
	Nitrite	.003	.001	.0023	.003	.001	.0020
	Nitrate	.01	<.01	<.01	.04	<.01	.020
	Total Phosphorus	.022	.005	.0118	.015	.007	.010
	Soluble Phosphorus	.003	.001	.0014	.005	.001	.0023

* 1 metre below surface

** 1 metre above bottom

TABLE 4 (Continued)

STATION	PARAMETER	SURFACE* MAXIMUM	MINIMUM	MEAN	BOTTOM** MAXIMUM	MINIMUM	MEAN
6	Free Ammonia	.01	.00	<.01	.04	.00	.01
	Total Kjeldahl	.28	.17	.248	.36	.17	.251
	Nitrite	.003	.001	.0020	.003	.001	.0015
	Nitrate	.01	<.01	<.01	.09	.04	.060
	Total Phosphorus	.016	.006	.0100	.024	.007	.0131
	Soluble Phosphorus	.008	.001	.0024	.007	.001	.0029
7	Free Ammonia	.01	.00	<.01	.01	.00	<.01
	Total Kjeldahl	.42	.10	.268	.38	.16	.240
	Nitrite	.003	.001	.0019	.004	.001	.0016
	Nitrate	.01	<.01	<.01	.09	.04	.061
	Total Phosphorus	.015	.006	.0091	.033	.005	.0170
	Soluble Phosphorus	.003	.001	.0016	.006	.001	.0026
8	Free Ammonia	<.01	.00	<.01	<.01	.00	<.01
	Total Kjeldahl	.34	.19	.297	.31	.17	.223
	Nitrite	.003	.001	.0016	.003	.001	.0015
	Nitrate	<.01	<.01	<.01	.06	<.01	.045
	Total Phosphorus	.012	.005	.0075	.018	.006	.0118
	Soluble Phosphorus	.002	.001	.0012	.005	.002	.0033
9	Free Ammonia	<.01	.00	<.01	<.01	.00	<.01
	Total Kjeldahl	.36	.21	.235	.30	.16	.208
	Nitrite	.003	.001	.0022	.003	.001	.0020
	Nitrate	<.01	<.01	<.01	.08	.03	.050
	Total Phosphorus	.023	.006	.0105	.027	.006	.0167
	Soluble Phosphorus	.009	.001	.003	.013	.001	.0057
10	Free Ammonia	<.01	.00	<.01	<.01	.00	<.01
	Total Kjeldahl	.35	.18	.215	.33	.16	.247
	Nitrite	.003	.001	.0018	.003	.001	.0018
	Nitrate	<.01	<.01	<.01	.08	.03	.045
	Total Phosphorus	.015	.004	.0102	.018	.007	.0133
	Soluble Phosphorus	.007	.001	.0028	.006	.001	.0030

* 1 metre below surface

** 1 metre above bottom

DISCUSSION

The Shebandowan Lakes reveal conditions which are indicative of the early stages of mesotrophy with some areas more advanced than others. The lakes may be classed as holomictic except in those areas where continuous turn-over prevailed, notably the shallow stations. Generally, however, the lakes established thermoclines typical of lakes of this nature with only minor fluctuations in the rate of descent of the metalimnion being influenced by accentuated cooling temperatures experienced in August of 1972.

Light transmission into the lake is rather low as reflected by the data presented in Table 1. Water transparency is governed by the quantity of suspended particulate matter (i.e. phytoplankton, zooplankton or silt) and coloured material (i.e. humic acid and tannans) in the water.

When one considers the relatively low levels of chlorophyll a pigment compared to Secchi disc values, one must assume something other than plant material as a factor in reduced light transmission.

Shallow water stations 1, 3, and 4 had a mean Secchi disc value of 2.3 metres indicating light penetration $\frac{1}{2}$ that experienced at open water stations. Scouring of bottom sediments and material brought into the lake from inflowing streams could account for the reduced Secchi disc values generally and specifically at the shallower stations.

When considering the recreational potentials of any lake, particular attention should be paid to the chemistry of the water and its relation to both wildlife and man. Man's preference for soft water in terms of everyday use is often a deciding factor when consideration is given to develop a lake.

The natural separation point between hard and soft waters is 40 mg/l as indicated by Moyle (1949). Alkalinities of the Shebandowan Lakes ranged between 22 and 25 mg/l with a mean value of 21.6 mg/l. On the basis of these data, the lakes may be classified as being soft water bodies.

When one examines the chemistry of the hypolimnion and compares it to that of the surface waters, it is quite apparent that differences do exist between the three lakes; however the processes going on in the lakes are not readily apparent from a superficial examination of the data.

The surface waters of the three lakes are uniform in that they are in constant contact with the atmosphere and may in fact move from one lake to another in the direction of flow. Bottom waters under stratification are physically isolated from all others including those of the surface, and therefore tend to be dependent on internal reactions.

It is evident that reactions are taking place in all three lakes, breaking down organic materials of either the previous year's or the present year's production of biological growth.

Lower Shebandowan Lake reveals a higher productivity of biological forms, most probably of aquatic plants (Vander Wal and Stedwill) which have therefore placed a greater stress on the lake in order to break them down. Consequently, the two upper lakes have higher free CO_2 levels and associated depressed pH levels in the hypolimnion due to the varying degrees of decomposition than does lower Shebandowan Lake. This does not suggest, however, that the two upper lakes are in a more eutrophic condition than the lower lake, but that they are capable of maintaining the rate of decomposition of organic products, this being verified by adequate dissolved oxygen levels in the hypolimnion. Lower

Shebandowan Lake data reveal conditions which would suggest that the rate of breakdown of material has been depressed by the associated low dissolved oxygen levels.

The deoxygenation of the bottom waters in Upper, Middle and Lower Shebandowan Lakes to levels below 5 mg/l, the minimum level considered essential for maximum sustenance of cold water fish species, may be partially accounted for by the decomposition of the present year's production of algae, or, in the case of Lower Shebandowan, the previous years' production as well as organic material carried in from the upper lakes and watershed.

Of concern, possibly, should be some of the low pH values encountered with the associated oxygen depletions. In some areas, pH levels did reach the lower critical point of 6.5 for sustaining most fish species. It is quite probable that some levels did decrease to a point below 6.5 in poor water circulation areas, such as rock crevices, with a resulting mortality in either fish eggs and/or larvae.

Additional data in Tables 1 and 2 support previous discussion in the lakes' hypolimnetic waters.

Acidity values substantiate the pH findings for the lake, and accentuate the fact that more organic decomposition is taking place in Upper and Middle Shebandowan Lakes than that of Lower Shebandowan. Total Kjeldahl nitrogen values suggest that even though there may be more decomposition occurring in the two upper lakes, there is more nitrogen tied up in organic material in Lower Shebandowan Lake. This is born out when one considers nitrate concentrations for the three lakes. It is quite evident that much of the nitrogen in the two upper lakes is in the inorganic form whereas that of Lower Shebandowan is in the

organic form. This is revealed in the nitrate values of .046, .065 and .003 PPM for Upper, Middle and Lower Shebandowan Lakes respectively.

Generally, troublesome levels of algae and vascular aquatic plants may appear when total phosphorous concentrations approximating 0.02 mg/l are attained. Inspecting the averages of total phosphorous concentrations, one would assume normal algae and aquatic plant densities. Some bays in the system, however, may be areas of high production because of localized conditions of abundant nutrients, available light and elevated water temperatures.

BIOLOGICAL RESULTS AND DISCUSSION

Chlorophyll *a*

Chlorophyll *a* concentrations (ug/l) for the eight sampling periods are indicated in Table 5, and show that a very narrow range of chlorophyll concentrations was encountered in Lake Shebandowan. The mean values for Upper, Middle and Lower Shebandowan lakes were 1.0, 1.1, and 1.1 respectively. The maximum value of 3.8 ugm/l was encountered at Station 9 on July 4.

Chlorophyll *a* - Secchi disc Relationship

As indicated earlier, chlorophyll *a* measures the amount of photosynthetic green pigment in algae while water clarity, which is one of the most important parameters used in defining the trophic condition of a lake, is determined by means of the Secchi disc. Ministry of the Environment personnel have noted a hyperbolic-like relationship between chlorophyll *a* concentrations and Secchi disc readings for lakes of Precambrian origin. Figure 3 describes this relationship for 945 sets of data collected from approximately sixty lakes in the province. Points for eutrophic or highly enriched lakes are characterized by high chlorophyll concentrations and poor water clarity and are situated along the vertical axis of the curve while oligotrophic waters which have low chlorophyll *a* levels and allow a significant amount of light to penetrate lie along the horizontal limb. Data for mesotrophic lakes would be situated in the middle portion of the hyperbolic-like curve. Figure 4 indicates the relative position of Lake Shebandowan to other lakes in the province, being situated between the mesotrophic Lake Ontario and the more oligotrophic Lakes Superior, Joseph, and Huron. From the chlorophyll and Secchi disc data

Table 5: Chlorophyll a values (ug/l) for 10 stations on Lake Shebandowan during 1972.

STATIONS	JUNE 12	JUNE 27	JULY 4	JULY 17	AUG. 1	AUG. 9	AUG. 28	SEPT. 6	MEAN
1	0.5	-	-	1.0	1.2	1.0	1.6	-	1.1
2	0.8	-	0.9	1.0	1.4	-	1.3	-	1.1
3	1.1	-	0.8	1.0	1.6	0.9	1.1	1.3	1.1
4	0.8	0.8	1.1	1.1	-	1.0	1.8	-	1.1
5	0.9	0.8	0.9	1.0	1.5	1.3	1.5	1.3	1.1
6	0.7	0.6	-	1.0	1.1	1.0	1.3	1.1	1.0
7	1.0	0.7	0.9	1.0	1.9	1.0	1.0	1.2	1.1
8	0.8	0.9	-	1.0	-	-	-	1.0	0.9
9	0.5	0.7	3.8	1.0	-	1.0	-	1.0	1.3
10	0.8	0.5	0.7	1.0	-	1.0	-	1.3	0.9

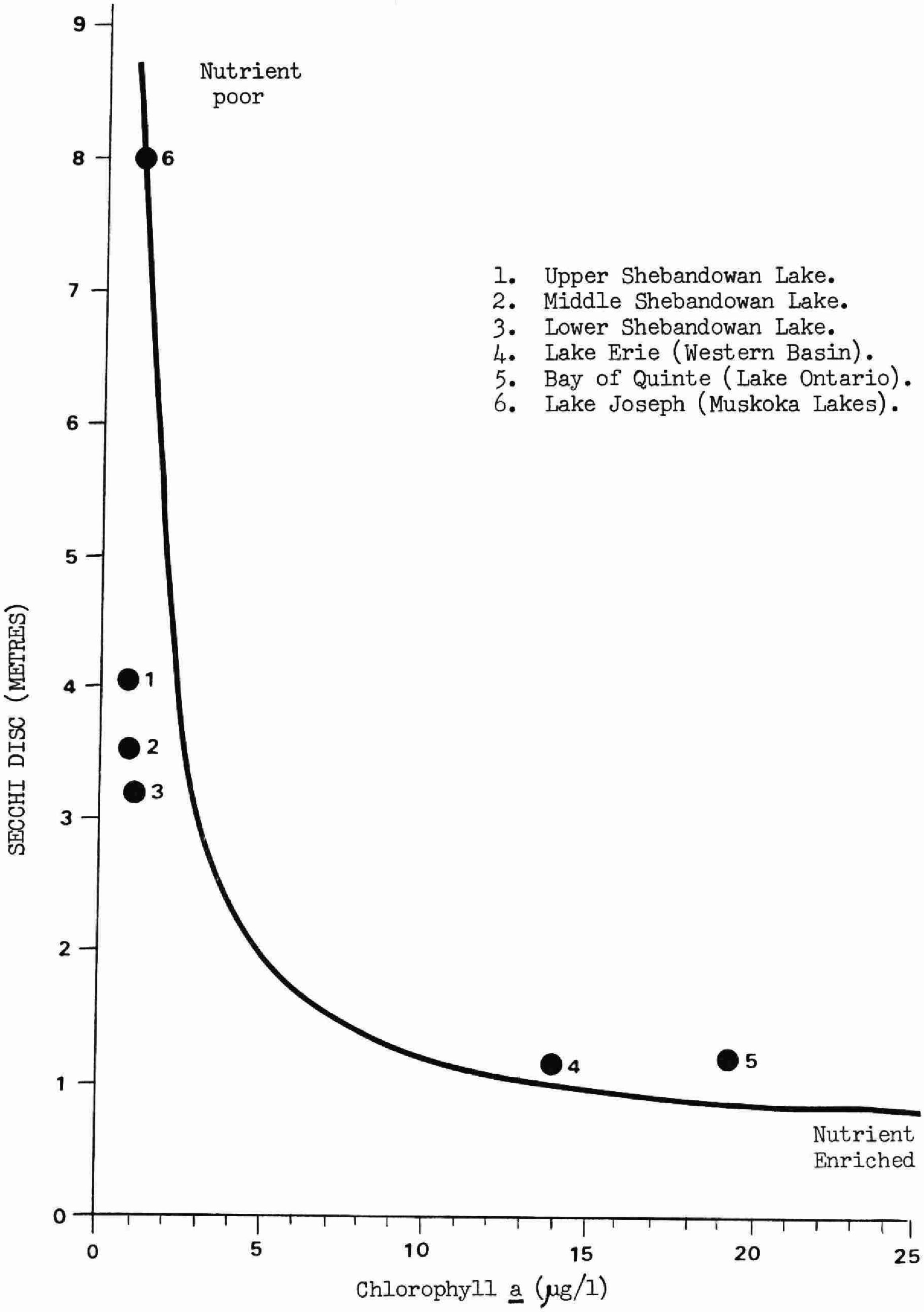


Fig. 3. The relationship between chlorophyll a and Secchi disc for Upper, Middle and Lower Shebandowan Lakes. Values for the lakes are based on means of values collected during the summer of 1972. Also information from 3 other lakes is included as an indication of the relative status of the Shebandowan study lakes.

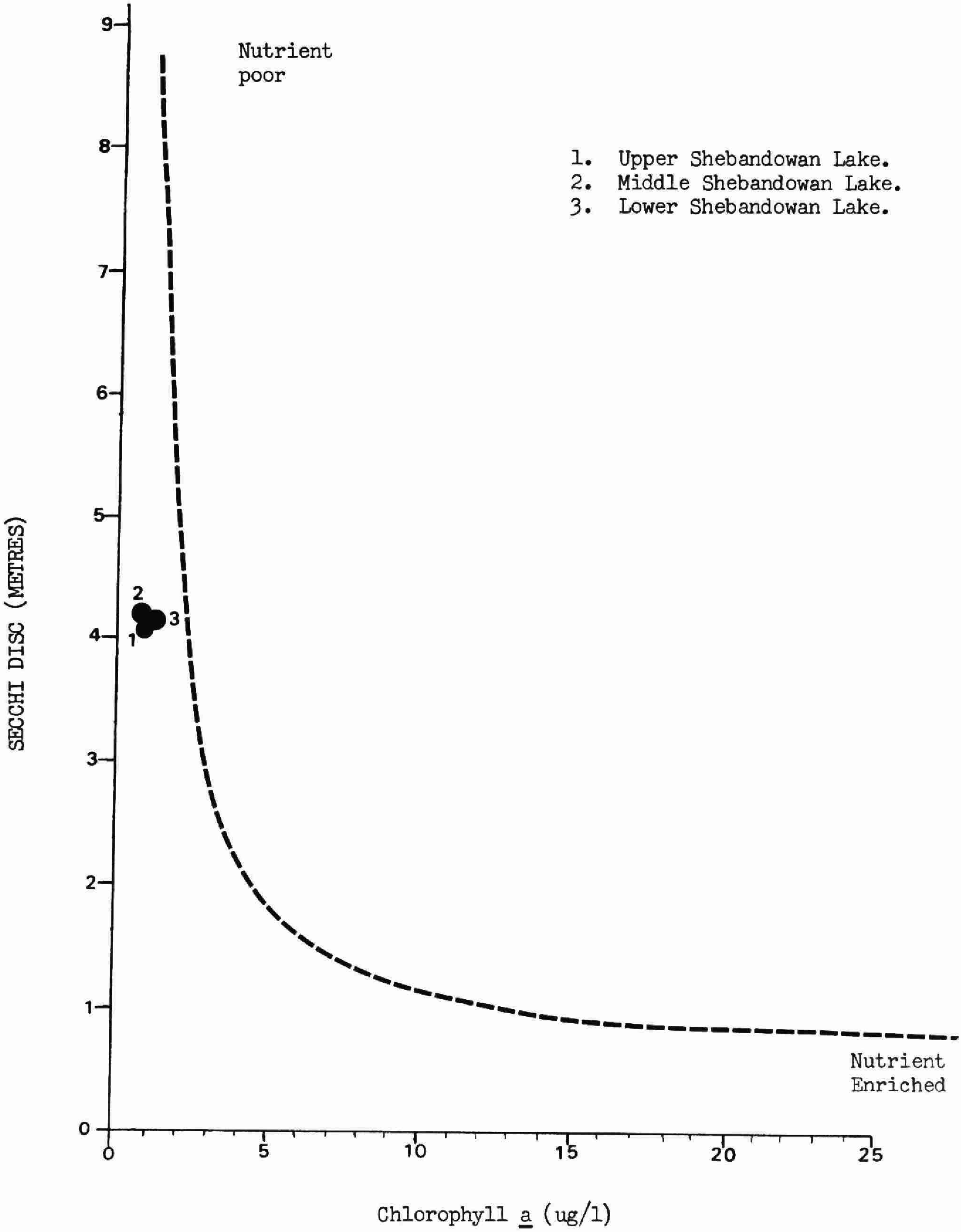


Fig. 4. The relationship between chlorophyll a and Secchi disc for Upper, Middle and Lower Shebandowan Lakes, excluding shallow water stations.

available, it is apparent that the Shebandowan lakes are in the early stages of mesotrophy; however, the low chlorophyll values may suggest a high turbidity due to suspended particulate matter other than algae, reducing water clarity, which would alter the position of the lake on the graph. As shallow water stations were included, Figure 4 depicts the relative positions of the three lakes to each other excluding the data received for shallow water due to turbidity interference.

It appears that Middle Shebandowan has the lower productivity when looking at chlorophyll a and water transparency parameters.

Phytoplankton

Phytoplankton data are presented in Tables 6 and 7. Figures 5, 6, 7, 8 and 9 graphically show the total population and species composition for each of the ten stations. Comparing the three lakes, it appears that Upper Lake Shebandowan is the most productive of the three lakes surveyed, with a mean of 1323 A.S.U.'s. This decreased through Middle Shebandowan Lake to Lower Shebandowan Lake where a mean of 1080 was encountered.

In June when phytoplankton levels were lowest the flora were dominated by the flagellated species Rhodomonas minuta Skuja and Cryptomonas erosa Ehr. Throughout the remainder of the sampling period, the most important species included the blue-greens Aphanothece clathrata G. S. West, Gomphosphaeria lacustris Chodat and Chroococcus spp. Relatively high levels of similar blue-green species exist in many of the larger soft-water lakes in southeastern Ontario (i.e. Lakes Muskoka, Joseph, Rosseau and Simcoe).

Table 6 Summary of phytoplankton data collected from ten sampling stations on Lake Shebandowan during the ice-free period of 1972. All results are expressed as areal standard units per millilitre.

Station	Minimum	Date	Maximum	Date	Mean
1	67	12/6	2,918	17/7	953
2	126	12/6	3,487	17/7	1,167
3	127	12/6	3,021	28/8	1,528
4	102	12/6	2,296	4/7	1,260
5	141	12/6	1,995	9/8	940
6	125	12/6	1,766	17/7	877
7	117	12/6	3,128	1/8	1,166
8	218	6/9	2,511	4/7	1,033
9	245	6/9	4,433	4/7	1,463
10	242	12/6	2,526	17/7	1,473

Table 7, Average and Range of Algal Populations (A.S.U.) for seven groups at 10 stations on Lake Shebandowan during 1972

GROUP	DATE							
	12/6	27/6	4/7	17/7	1/8	9/8	28/8	6/9
Bacillariophyceae	4-34 13.0	3-45 16.4	3-234 23.4	1-76 20.2	2-9 5.5	8-267 52.1	21-458 129.6	7-825 145.4
Myxophyceae	1-357 100.0	127-1652 563.9	463-4284 1771.6	702-3381 1910.9	785-3062 1743.7	307-1866 942.7	258-2404 893.1	85-1419 584.3
Chlorophyceae	3-35 11.3	2-58 24.5	6-181 42.7	0-20 8.1	5-16 10.7	0-16 5.2	6-21 11.7	4-56 17.3
Cryptophyceae	32-92 55.3	33-80 48.7	24-72 43.3	13-71 31.2	22-33 27.7	7-53 29.4	13-63 27.8	30-75 4.4
Chrysophyceae	3-16 9.8	3-33 12.7	1-16 8.6	12-498 94.3	28-220 87.5	18-204 62.7	25-111 71.7	12-74 25.3
Dinophyceae	0-5 1.0	0-2 0.4	0-4 0.5	— —	— —	0-1 0.1	— —	0-20 2.8
Euglenophyceae	— —	— —	— —	— —	— —	— —	— —	— —
Totals	67-452 190.8	244-1742 666.6	597-4433 1886	765-3487 2064.7	868-3128 1875.1	414-1995 1094.7	438-3021 1134	245-1876 824.7

Note: Top line denotes range encountered from Lake Shebandowan at 10 stations.
Bottom line is the mean for any one date.

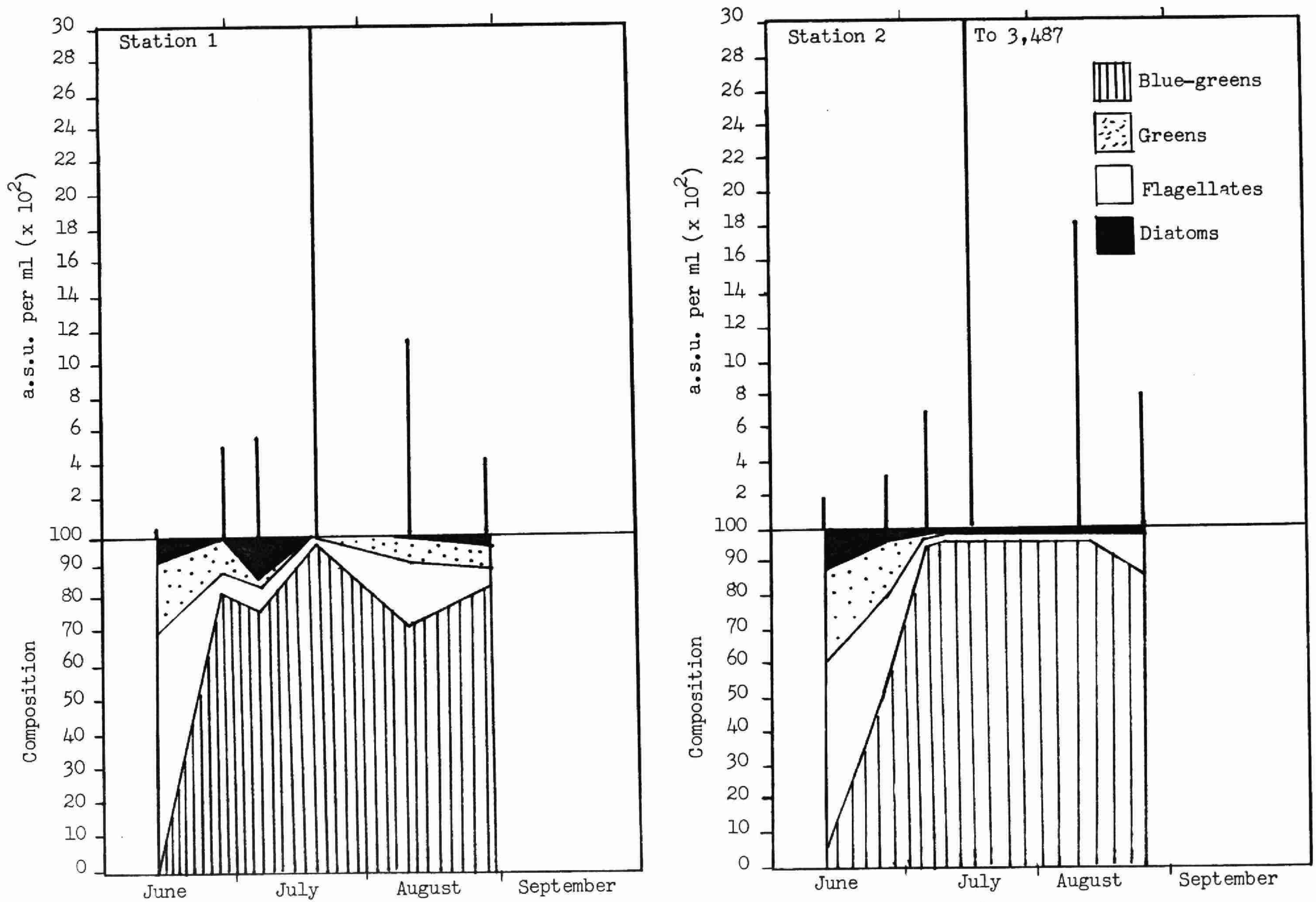


Figure 5 Algal stocks (upper portion of panel) and percent composition (lower panel) at Stations 1 and 2.

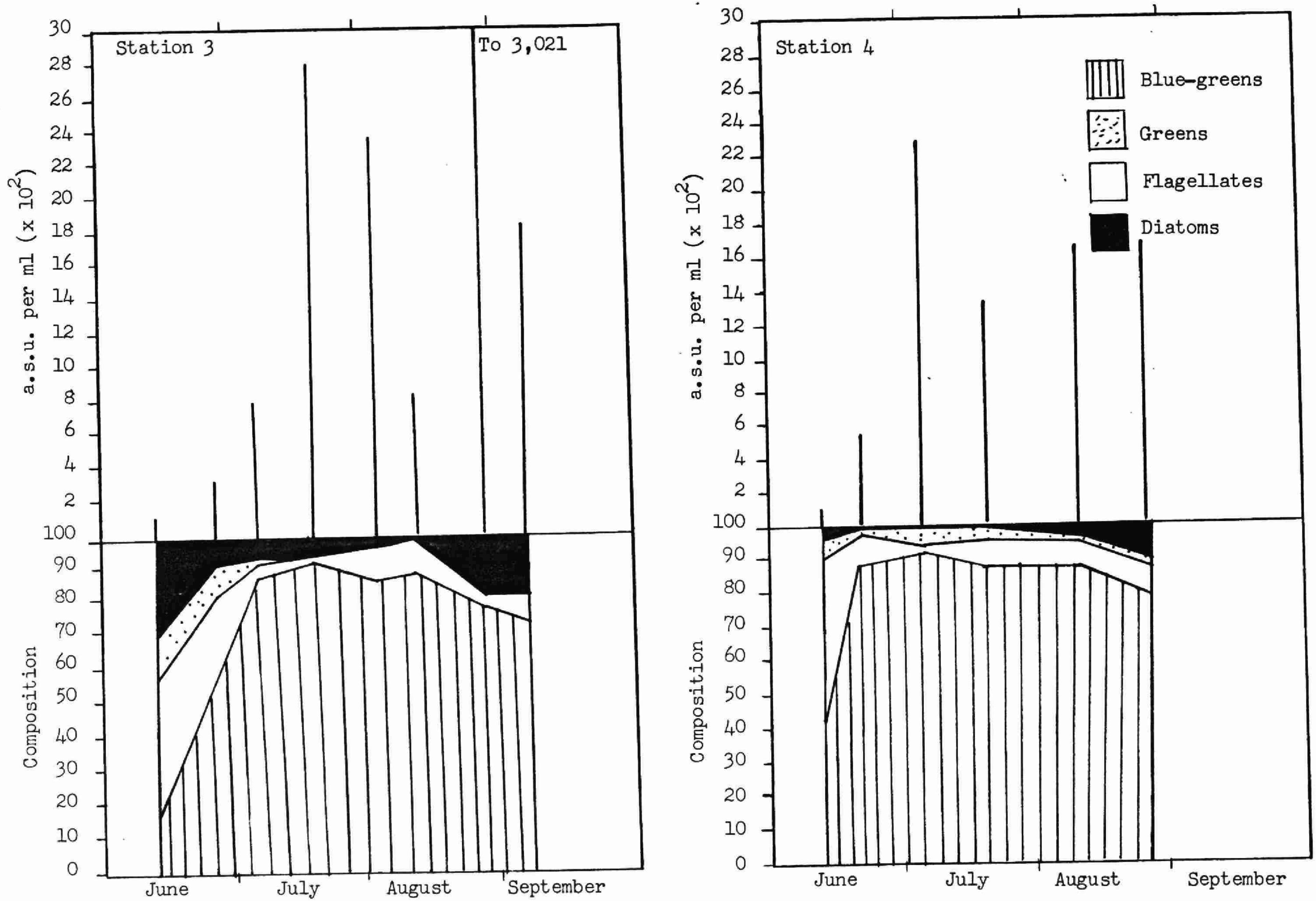


Figure 6 Algal stocks (upper portion of panel) and percent composition (lower panel) at Stations 3 and 4 Shebandowan Lake, 1972.

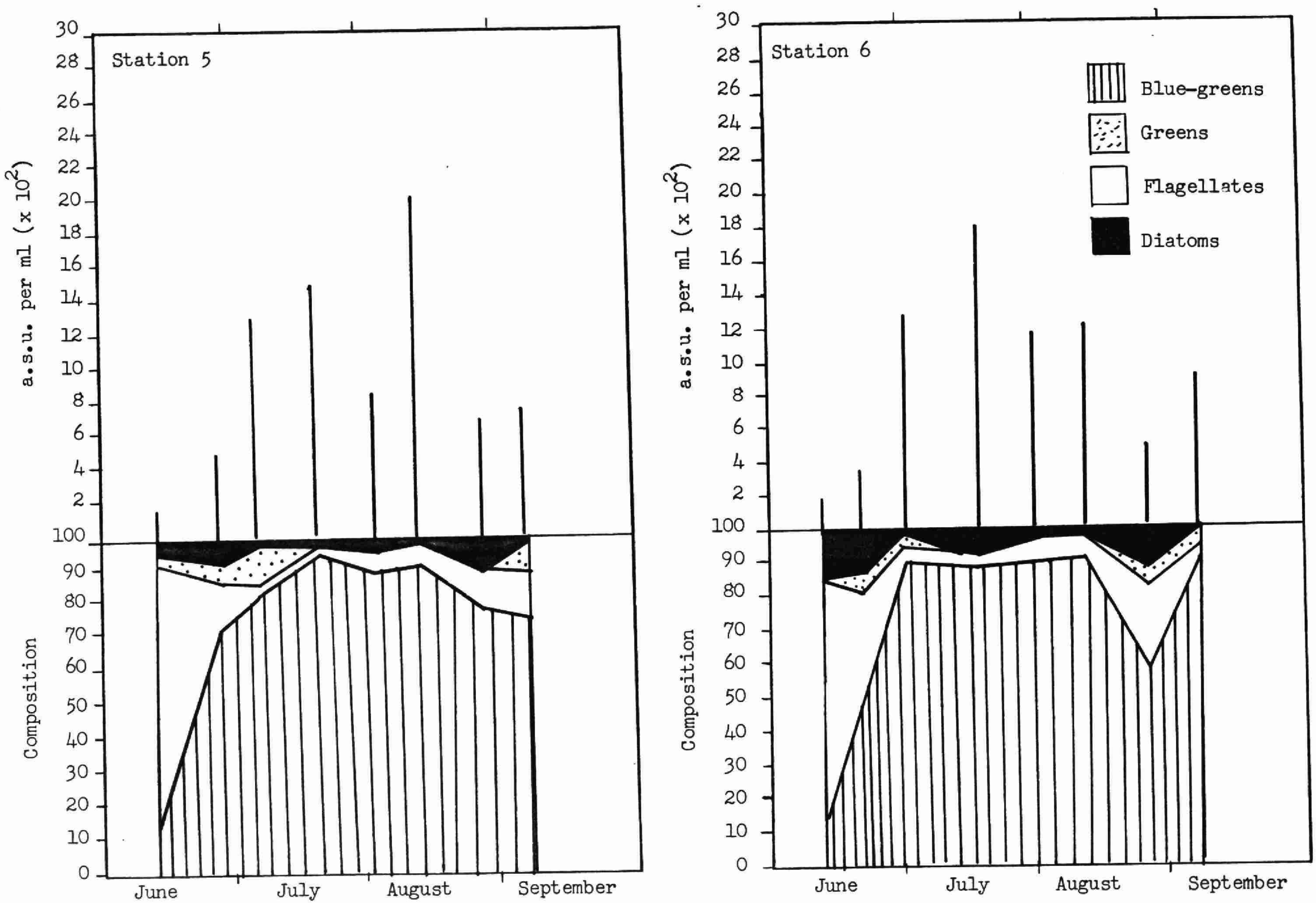


Figure 7 Algal stocks (upper portion of panel) and percent composition (lower section of panel) at stations 5 and 6, Lake Shebandowan, 1972.

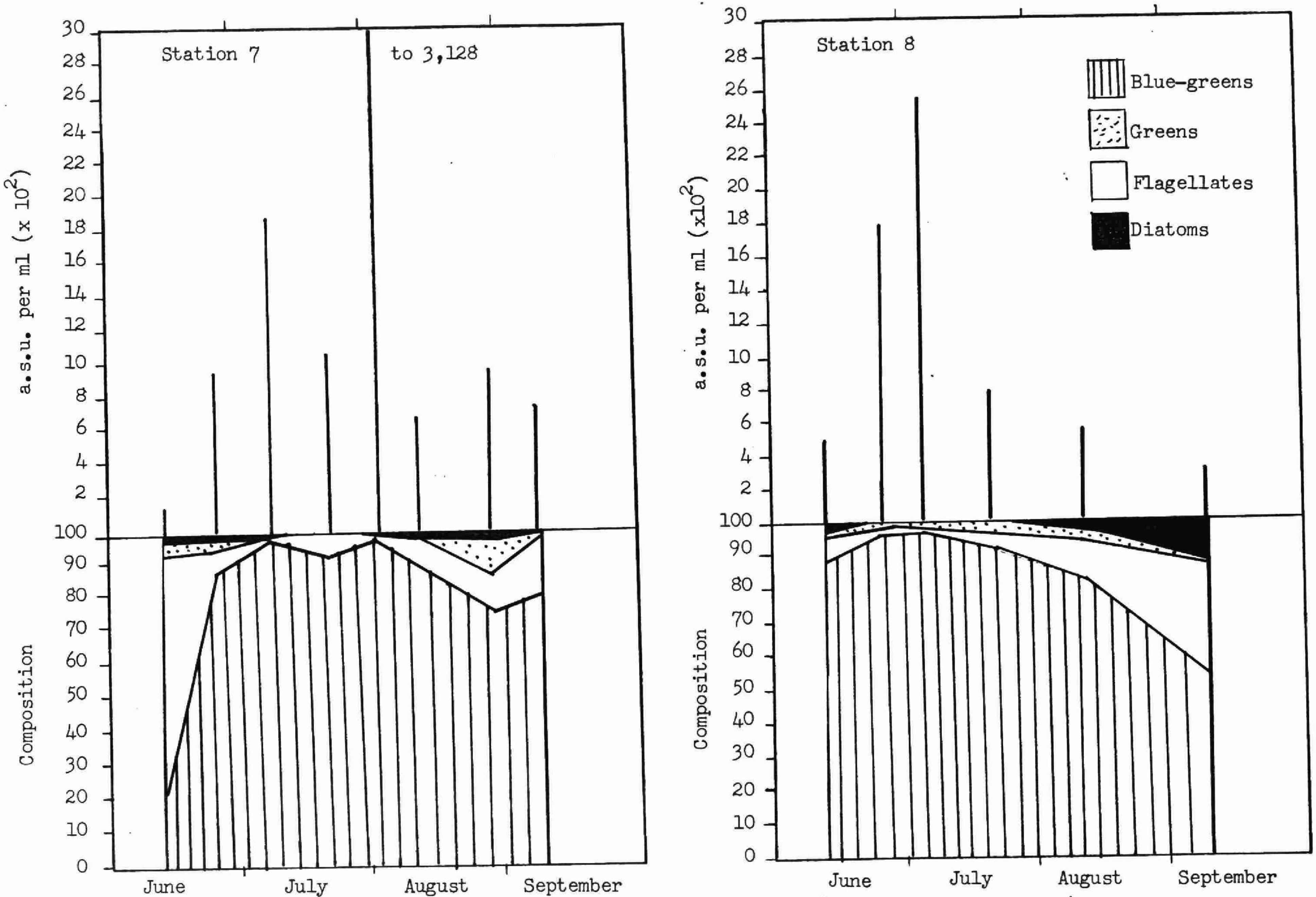


Figure 8 Algal stocks (upper portion of panel) and percent composition (lower section of panel) at Stations 7 and 8, Lake Shebandowan, 1972.

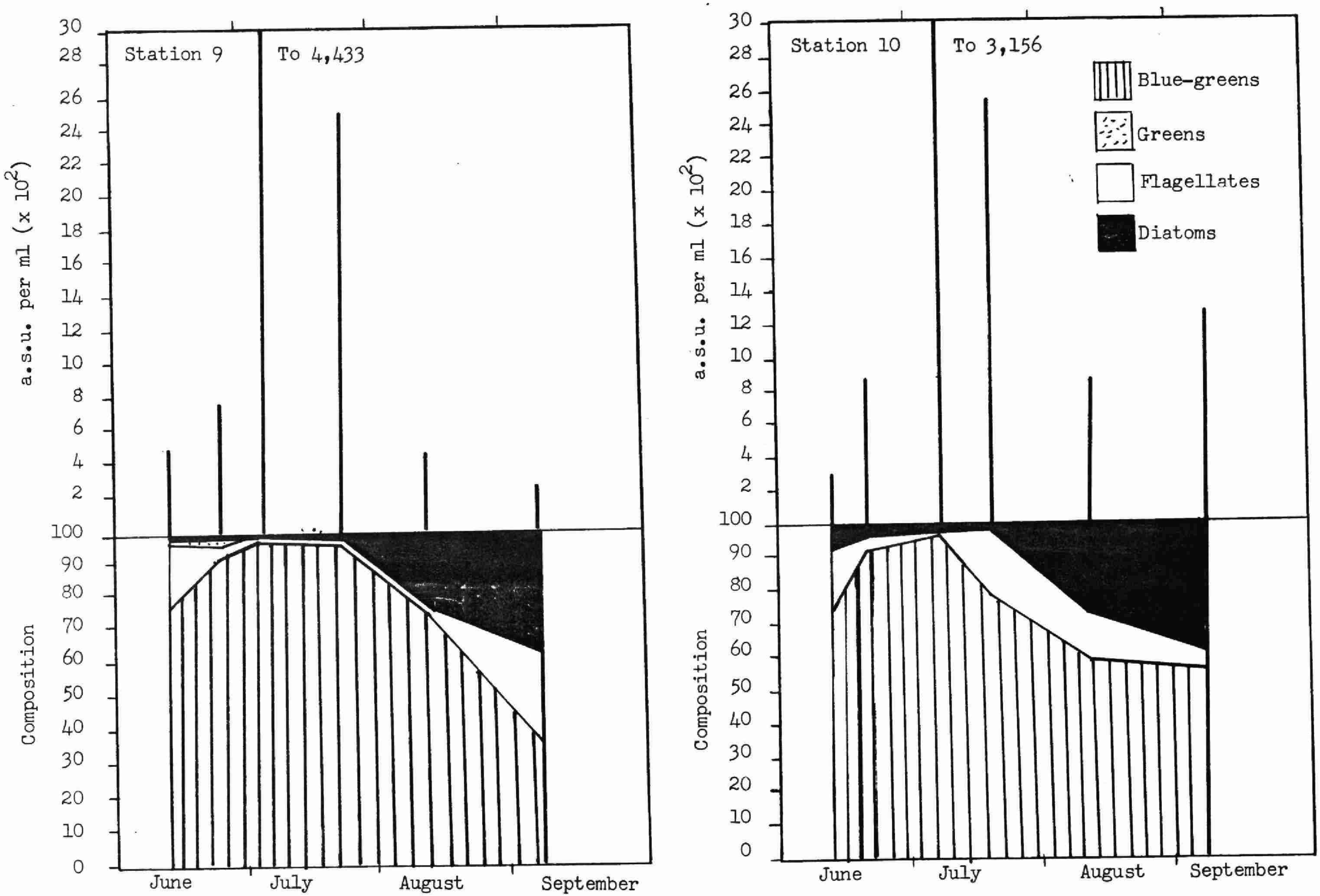


Figure 9 Algal stocks (upper panel) and percent composition (lower portion of panel) at stations 9 and 10, Lake Shebandowan 1972.

Table 8, provides for comparative purposes, a breakdown of phytoplankton conditions for several lakes in Ontario. Although only few data are available from Lake Shebandowan (considering the entire ice-free period of the year) and comparisons are between differing years, the information is quite useful and informative. It is apparent that phytoplankton stocks of Stations 1, 5 and 6 of Lake Shebandowan are of a similar order of magnitude to those of Skeleton Bay of Lake Rosseau, a system which is classed as early mesotrophic on the basis of its phosphorus loading - mean depth relationships. Stations 2, 3, 4 and 7 through 10 appear slightly more productive and perhaps should be ranked as decidedly mesotrophic in status. Significantly, standing stocks in Lake Shebandowan were substantially lower than those recorded from the Union Water Treatment Plant, Dows Lake, Riley Lake, Penetang Harbour and Gravenhurst Bay - five extremely enriched bodies of water.

As indicated earlier, the species encountered are ubiquitous during the summer months to relatively large lakes throughout the Province. Alagal types (i.e. Anabaena, Aphanizomenon, and Microcystis) having "water-bloom" characteristics were not identified from Shebandowan Lake.

Aquatic Vegetation

Discussion of this aspect of the survey is best dealt with by referring to the report by Vander Wal and Stedwill 1973, on aquatic macrophytes of the Shebandowan Lakes System.

In summary here, that report stated that; "The Shebandowan Lakes system was found to contain a general pattern of scattered and sparse populations of aquatic vascular plants. The transect method of sampling indicated that Isoetes spp., Myriophyllum spp. and Potamogeton

Table 8 Summary of phytoplankton data collected from various sources during the summer of 1969, except for Collingwood information which was obtained during the ice-free period of 1968. All results are expressed in areal standard units per millilitre.

Municipality	Source	Number of Samples	Areal Standard Units/ml Range	Areal Standard Units/ml Mean	Trophic Status
-	Lake Joseph	21	31- 1,153	402	Oligotrophic
-	Lake Rosseau	22	54- 1,880	479	Oligotrophic
-	Lake Muskoka	45	98- 1,469	510	Oligotrophic-mesotrophic
-	Little Lake Joseph	23	187- 1,945	733	Oligotrophic
-	Skeleton Bay	22	200- 1,869	890	Mesotrophic
-	Dudley Bay	22	260- 1,285	646	Oligotrophic
-	Gravenhurst Bay	15	134- 6,402	2,686	Eutrophic
-	Riley Lake	72	141- 3,651	1,912	Eutrophic
Ottawa	Dows Lake	20	455-13,600	5,581	Eutrophic
Penetanguishene	Penetang Bay	36	281- 9,577	2,510	Eutrophic
Union	Lake Erie - Western Basin	26	1,022- 7,147	3,190	Eutrophic
Collingwood	Georgian Bay	207	7- 708	226	Oligotrophic
Grand Bend	Lake Huron	25	23- 559	155	Oligotrophic
Hamilton	Lake Ontario	26	128- 1,313	276	Oligotrophic-mesotrophic
-	Lake Shebandowan #1	6	67- 2,918	953	Early mesotrophic
-	Shebandowan Lake #2	6	126- 3,487	1,167	Mesotrophic
-	Shebandowan Lake #3	8	127- 3,021	1,528	Mesotrophic
-	Shebandowan Lake #4	6	102- 2,296	1,260	Mesotrophic
-	Shebandowan Lake #5	8	141- 1,995	940	Early mesotrophic
-	Shebandowan Lake #6	8	125- 1,766	877	Early mesotrophic
-	Shebandowan Lake #7	8	117- 3,128	1,166	Mesotrophic
-	Shebandowan Lake #8	6	218- 2,511	1,033	Mesotrophic
-	Shebandowan Lake #9	6	245- 4,433	1,463	Mesotrophic
-	Shebandowan Lake #10	6	242- 2,526	1,473	Mesotrophic

robbinsii were the most abundant plants present in Lake Shebandowan. Furthermore the quadrat method of sampling revealed the possibility of higher plant densities in Lower Shebandowan than in the other two areas of the Lake."

It has been noted in this regard that when considering two populations of aquatic flora, such as phytoplankton and rooted aquatics, one will tend to monopolize causing the other to decrease in numbers. This is indicated in Lower Shebandowan Lake in that it does have a lower algal population but a considerably higher vascular plant population as referred to previously. This may suggest that conditions in Lower Shebandowan Lake are more conducive to rooted plants than phytoplankton. This is born out by referring to substrates referred to by Vander Wal and Stedwill in the three lakes, which suggests that the most abundant and diverse populations were found in the silt substrate, much of which covers the bottom of Lower Shebandowan Lake.

SUMMARY AND CONCLUSIONS

During the ice-free period of 1972, the Water Quality Branch of the Ministry of the Environment undertook a survey to assess the trophic status of the Shebandowan Lakes system.

Based on the results of 8 visits to the study area, the physical and chemical conditions present in Lake Shebandowan indicate that the Lake is generally in the early stages of mesotrophy. Algae production is higher in the two upper lakes as indicated by algae enumeration, however, this is offset by a higher rooted-plant population in Lower Shebandowan Lake. Classical indications of eutrophication in Lake Shebandowan were evidenced by relatively low Secchi disc readings, oxygen depletions in the hypolimnetic waters, elevated total phosphorus, iron and silica in the deeper waters and a depression of pH in the deeper strata.

This study was not designed to provide a definite indication of the underlying causes of the present degree of enrichment in Lake Shebandowan. However, enrichment studies have been carried out by staff of the Ministry of the Environment on a number of similarly affected lakes in Southern Ontario. Cottage waste-treatment facilities may adequately curb bacterial and nutritional contamination; however, it is obvious that many systems around the province have been installed where local conditions (soil depth, permeability, slope, vegetation cover, depth to water table, distance to lake, etc.) are unsatisfactory and treatment is ineffective.

RECOMMENDATIONS

1. Future shoreline development on Lake Shebandowan should not be permitted unless facilities are provided which will prevent any translocation or seepage of organic wastes, bacteria and/or nutrients to the lake.

2. In order to protect the present quality of Lake Shebandowan for the greatest number of beneficial uses, treatment of wastes from domestic or industrial sources should be stringent enough to adequately satisfy the Ministry's water quality criteria for the protection of fish and wildlife and for recreational use by man.

3. Research must be implemented to demonstrate the suitability of alternatives and/or modifications to existing septic tank tile-field systems where these cannot be expected to function adequately. There are numerous cottages now developed in situations where adequate nutrient and/or bacterial containment is not being provided (i.e., bald rock areas and small islands).

4. Municipal officials in co-operation with provincial government agencies must take the initiative to ensure the provision of an adequate collection and disposal system which would render total containment, pump-out facilities a practical solution to waste disposal in difficult areas.

5. The use of washing compounds containing phosphates should be avoided. If clothes washing is carried out at summer cottages it is not necessary to use granular detergents containing phosphates, since ordinary soap products perform adequately in water from soft-water lakes. Although the phosphate content of all household detergents

has been reduced to approximately 20% as P_2O_5 (effective August, 1970) the exclusive use of laundry soaps would provide a significant reduction in the potential enrichment by phosphates. Most household liquid dishwashing products do not contain phosphates and so do not contribute algae-producing nutrients.

6. As a result of the findings of both this report and the report on aquatic macrophytes, studies should be undertaken to assess domestic waste-treatment facilities. A study should be undertaken to provide a quantitative assessment of aquatic plant growth as well as a program to monitor chlorophyll levels.

ACKNOWLEDGEMENTS

The co-ordination of both field and laboratory work by Mr. D. M. Pugh is appreciated as well as the amount of time spent in preparing certain tabular material of this report.

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APPENDIX A

Field Methods

Between June 10 and September 10, 1972, physical, chemical and biological sampling was carried out on 8 occasions at ten different sites in the Shebandowan Lakes System (Fig. 2) by personnel of the Water Quality Branch in the Thunder Bay Regional Office.

Light transparency was measured by means of a Secchi disc, subsequently the euphotic zone was determined as twice the Secchi disc reading. Composite Biological samples for phytoplankton and chlorophyll analyses were collected by lowering a 40 ounce bottle with a restricted opening through the euphotic zone and preserving them with lugol's iodine and magnesium carbonate respectively. Chemical samples were collected at one metre below the surface and one metre above the bottom, by means of a Kemmerer water sampler. All chemical samples were poured into 32 oz. glass bottles and kept chilled until analyses, with the following exceptions; silica and free CO_2 which were placed in 32 oz. nalgene and 250 ml. gas bottles respectively. All analyses were performed at the Thunder Bay Regional Laboratories except for silica, phytoplankton and chlorophyll, which were shipped to Toronto for analyses.

Dissolved oxygen and temperature profiles were determined at each of the stations on each visit by means of a YSI Model 54 oxygen and temperature meter at each metre of depth.

Additional biological samples were collected during a three week period in July and August when an assessment of the standing crop of rooted aquatic plants was made. The major spawning beds and sheltered bays were examined with regard to species present and approximate populations. Samples of plants were collected and preserved in a colour

preserving solution of commercial formalin, glacial acetic acid, ethanol (50%) and cupric acetate for three days. The samples were then transferred to 4% formalin. Duplicate samples were also taken for herbarium specimens. Species diversity and frequence of occurrence was determined by using a 80 metre line marked every 5 metres. Plant species and densities were assessed every 5 metres along the line running perpendicular to the shore. Plant species were identified in situ if possible, or otherwise removed for later positive identification. Density ratings were determined by the following code:

1. Heavy growth: (H.G.) plants form a continuous mat, with virtually no space between individual plants.
2. Moderate growth: (M.G.) plants form dense clumps or patches.
3. Scattered growth: (S.G.) plants scattered along lake bottom with distinct spaces between individual plants.
4. Occasional growth: (O.G.) small groups of plants, or individual plants observed at irregular intervals.

Due to the short duration of time allowed for the survey, some bays were assessed merely by swimming a circle around the boat with a radius of about 30 feet and assigning a density rating using the above code. Percent composition of different species was determined by randomly throwing a quarter square metre quadrat and assessing the growth contained therein.

APPENDIX B

Laboratory Methods

Chemistry

Nutrient analyses were performed on chemistry samples for nitrogen (total Kjeldahl, nitrate, nitrite and free ammonia nitrogen as mg N/l), total and soluble phosphorus (as mg P/l), orthosilicate (as mg SiO_2/l), iron (as mgFe/l), alkalinity (as mg $CaCO_3$/l), conductivity (as micromhos @ 25.0^{o}C), Free CO_2 (as mg Co_2/l), and pH. Analyses were conducted following standard procedures (A.P.H.A. *et al*. 1965).

Phytoplankton Analyses

The algal samples were concentrated by allowing cells to settle for 72 - 96 hours, and the supernatant liquid then syphoned or decanted. Subsequently, the cells were resuspended in a 25 ml concentrate and 1 ml aliquot was transferred into a Sedgwick-Rafter counting cell. Most of the algal forms were identified to geneus at a magnification of 220X. Where accurate identifications were impossible, wet mounts were prepared and examined at higher magnifications. Quantitative results were expressed as areal standard units per millilitre. One areal standard unit is equal to an area of 400 square microns (Whipple 1914). Depending on the density of the concentrate, strips or field were counted.

Chlorophyll Analyses

Chlorophyll samples were prepared by biology staff in Toronto by filtering at least 500 millilitres of sample through 47 mm diameter filters under vacuum (15 psi). Analyses of the chlorophyll pigments contained therein were then acetone extracted and absorption of the extract was measured on an atomic absorption spectrophotometer for chlorophylls *a* and *b* (4).

Rooted Aquatics

Plants not identified in the field were identified microscopically and keyed out according to Fassett (5).

APPENDIX C

List of rooted Aquatic Macrophytes encountered in the Shebandowan Lakes system, June 12 - September 6, 1972.

Najadaceae

Potamogeton pectinatus L.

P. gramineus L.

P. Richardsonii (Benn.) Rydb.

P. epihydrus Raf.

P. Robbinsii Oakes

P. amplifolius Tuckerm

Najas flexilis

Polygonaceae

Polygnum natans Eaton

Hydrocharitaceae

Vallisneria americana Michx.

Elodea (Anacharis) *canadensis* Michx

Haloragidaceae

Myriophyllum alterniflorum DC

var *americanum* Rugsley

Isoetaceae

Isoetes spp.

Equisetaceae

Equisetum spp.

Equisetaceae

Equisetum spp.

Lobeliaceae

Lobelia dortmanna L.

Cyperaceae

Eleocharis spp.

Scirpus spp.

Alismaceae

Sagittaria latifolia Willd

Ranunculaceae

Ranunculus spp.

Sparganiaceae

Sparganium americanum Nutt

Lentibulariaceae

Utricularia vulgaris L.

Nymphaceae

Nuphar advena Ait

Nymphaea odorata Ait

Brasenia Schreberi Guel

Pontederiaceae

Heteranthera dubia (Jacq.) MacH.

Compositae

Bidens beckii G.

Typhaceae

Typha spp.

Characeae (Algae)

Nitella spp.

Chara spp.

APPENDIX D

List of Phytoplanktonic genera (or species as indicated) encountered in samples collected from the Shebandowan Lakes System, June 12 - September 6, 1972.

Bacillariophyceae

Achaanthes spp.

Asterionella spp.

Asterionella formosa Hassal

Cyelotella spp.

Cymbella spp.

Eunotia spp.

Fragilaria spp.

Crotonensis Kitton

Melosira spp.

Navicula spp.

Nitzschia spp.

Rhizosolenia spp.

Rhizosolenia eriensis H. L. Smith

Synedra spp.

Tabellaria spp.

Tabellaria fenestrata (Lyngb).) Kutzing

Chlorophyceae

Ankistrodesmus spp.

Arthrodesmus spp.

Bitrichia spp.

Botryococcus spp.

B. Braunii Kuetzing

Characium spp.

Chlamydomonas spp.

Chlorogonium spp.

Coelastrum spp.

Cosmarium spp.

Crucigenia spp.

C. tetrapedia (Kirchner) W. & G.S. West

Elakatothrix spp.

Gloeocystis spp.

Golenkinia spp.

Nephrocytium spp.

Oocystis spp.

Pediastrum spp.

Quadrigula spp.

Scenedesmus spp.

Schroederia spp.

Selenastrum spp.

Sphaerocystis spp.

Tetraedron spp.

Chrysophyceae

Chrysochromulina spp.

C. longispina

Chrysomonad spp.

Chrysosphaerella spp.

Dinobryon spp.

Mallomonas spp.

Synura spp.

Cryptophyceae

Rhodomonas spp.

R. minuta skuja

Cryptomonas spp.

Cryptumonas erosa Ehr.

Dinophyceae

Ceratium spp.

C. nirundinella

Glenodinium spp.

Euglenophyceae

Myxophyceae

Anabaena spp.

Aphanizomenon spp.

A. flos-aquae (L.) Ralfs

Aphanocapsa spp.

Aphanothece spp.

Aphanothece clathrata G. S. West

Chrococcus spp.

Dactylococcopsis spp.

Gomphosphaeria spp.

Gomphosphaeria lacustris Chodat.

Lyngbya spp.

Merismopedia spp.

Microcystis spp.

M. aeruginosa

Oscillatoria spp.

Pelogloea spp.

GLOSSARY OF TERMS

ALGAE - an assemblage of simple, mostly microscopic non-vascular plants containing photosynthetic pigments such as chlorophyll. Algae occur suspended in water (phytoplankton) and as filaments attached to rocks and other substrates. Some algae may produce nuisance conditions when environmental conditions are suitable for prolific growth.

BIOTA - all living organisms in a region.

BLUE-GREEN ALGAE - a group of algae with a blue-pigment, in addition to the green pigment - chlorophyll. A foul odour is often associated with the decomposition of dense 'water-blooms' of blue-green algae in fertile lakes.

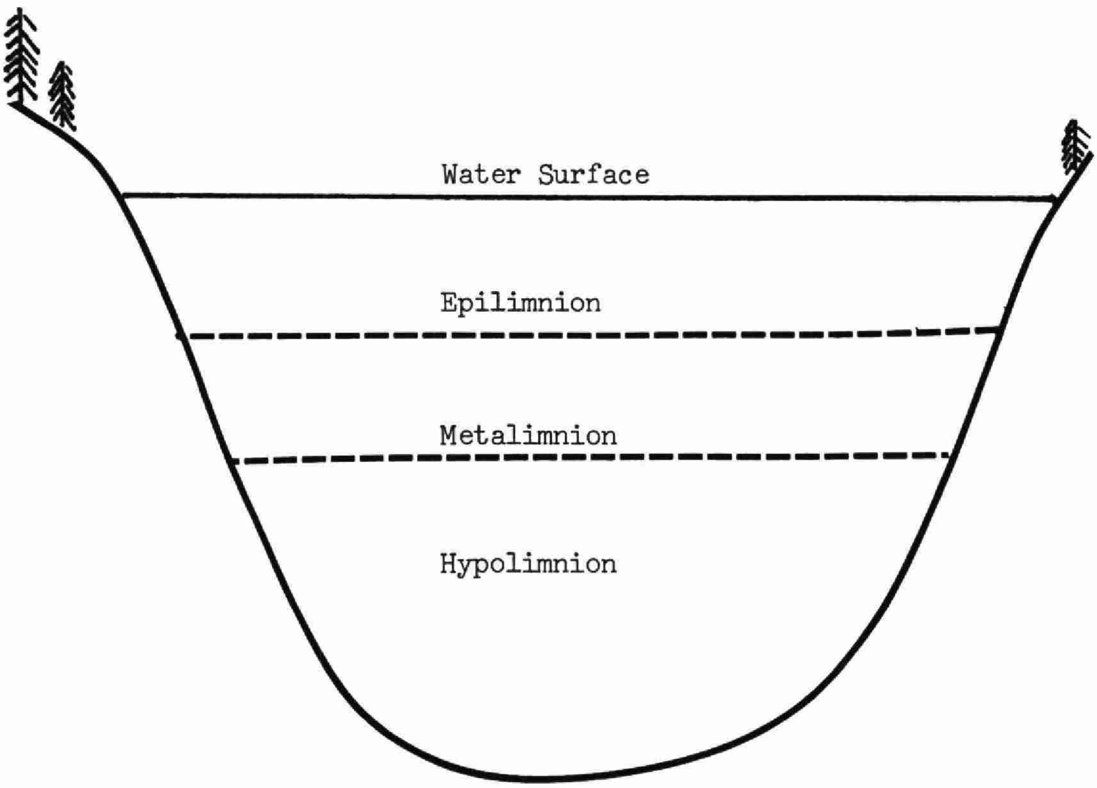
CLINOGRADE - a type of vertical oxygen distribution in a lake involving depletion of oxygen levels in the deeper waters.

DIATOMS - one of the most important groups of microscopic algae found in freshwater. Diatoms are distinguished by their silica cell walls (consisting of two halves, one fitting into the other like a box and its lid) and by their yellow or brown colour.

DISSOLVED OXYGEN - atmospheric oxygen which is dissolved in water and can be expressed as parts per million or percent saturation.

EPILIMNION - the uniformly warmer and turbulent superficial layer of a lake when it is thermally stratified during the summer. The layer above the thermocline (Figure i).

EUPHOTIC ZONE - the lighted region that extends vertically from the water surface to the level at which photosynthesis fails to occur because of ineffective light penetration.



EPILIMNION - the warmer upper layer of water

METALIMNION- the transition layer of rapid temperature change between the warmer epilimnion and colder hypolimnion

HYPOLIMNION- the colder water zone below the thermocline of the metalimnion

Figure i. Section of a stratified lake showing the three layers, resulting from thermal stratification.

EUTROPHICATION - The intentional or unintentional enrichment of a lake or stream owing to the presence of essential plant nutrients such as phosphorus and nitrogen.

FLAGELLATED ALGAE - a group of algae which have one or more whip-like appendages (flagella) per cell. The flagella are used for movement.

GREEN ALGAE - a group of algae which have pigments similar in colour to those of higher green plants.

HYPOLIMNION - the uniformly cold and deep layer of a lake when it is thermally stratified during the summer. The hypolimnion is below the thermocline (Figure i) and is generally removed from the surface influence (i.e. does not receive oxygen from the atmosphere).

LUGOL'S IODINE - a preservative for algae containing potassium iodide, iodine and water.

m - metre

$mgC/m^3/hr.$ - milligrams of carbon assimilated per cubic metre per hour.

$mgC/m^2/hr.$ - milligrams of carbon assimilated per square metre per hour; the amount of carbon fixed per square metre of euphotic zone.

MICRON - a unit of measurement equal to 0.001 millimetres.

ml - millilitre

ORTHOSILICATE - silica in water is detected as orthosilicate the results recorded in this report represent only the molybdate reactive portion of soluble silica. Silica is present in natural waters in soluble and colloidal forms. A silica cycle occurs in many

bodies of water containing organisms, such as diatoms which utilize silica in their skeletal structure. The silica removed from the water by the diatoms may be slowly returned by re-solution of the dead organisms.

pH - a means of expressing the degree of acidity or basicity of a solution. At normal temperature, neutral solution such as pure distilled water has a pH of 7, a basic solution has a pH greater than 7 and an acidic solution has a pH less than 7.

PHOTOSYNTHESIS - the process by which simple sugars are manufactured from carbon dioxide and water by living plant cells with the aid of chlorophyll in the presence of light.

PHYTOPLANKTON - free-floating microscopic algae which are slightly motile and exist at or near neutral bouyancy.

PLANKTON - an assemblage of micro-organisms, both plant and animal, that either have relatively small powers of locomotion or drift in the water subject to the action of waves and currents.

PRIMARY PRODUCTIVITY - the rate of photosynthetic carbon fixation by plants and bacteria forming the base of the food chain.

SECCHI DISC - a circular metal plate, 20 centimetres in diameter, the upper surface of which is divided into four equal quadrants and so painted that two quadrants directly opposite each other are black and the intervening ones white. The Secchi disc is used to estimate the depth of the euphotic zone.

SEDGWICK-RAFTER COUNTING CELL - a plankton-counting cell consisting of a brass or glass receptable 50 x 20 x 1 millimetres sealed to a 1 x 3 inch glass microscope slide. A rectangular cover glass large enough to cover the whole cell is required. The cell has a capacity of exactly 1 millilitre.

STANDING STOCK - the biota present in an environment at a selected point in time.

THERMAL STRATIFICATION - in the spring, vertical temperatures in a lake or reservoir are homogeneous from top to bottom. As summer advances, the surface waters become warmer and lighter than the underlying colder, denser waters. A thermal gradient or stratification is established in which various water layers can be defined (Figure i).

THERMOCLINE - the transition layer (Figure i) where rapid temperature change occurs between the upper warm water layer and the cold deep water layer. It is usually defined by a change in temperature of 1°C for each metre of water depth.

TROPHIC STATUS - depending on the degree of plant nutrient enrichment and resulting biological productivity, lakes are generally classified into three intergrading types: oligotrophic, mesotrophic and eutrophic. If the supply of plant nutrients to an extremely oligotrophic lake is progressively increased, the lake will become more mesotrophic in character; with further enrichment it will eventually become eutrophic.